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## Chronology, Uncertainty and GIS: A Methodology for Characterising and Understanding Landscapes of the Ancient Near East

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Dan Lawrence – Jennie Bradbury – Robert Dunford

# Chronology, Uncertainty and GIS: A Methodology for Characterising and Understanding Landscapes of the Ancient Near East

Multi-scalar; landscape; Near East; chronological modelling; GIS; remote sensing.

Modern archaeological research is confronted with a legacy of projects which stretch back to the early 20th century. Alongside this, massive amounts of disparate data are being generated by on-going excavation and survey. Scholars are also beginning to use satellite imagery to interpret and re-interpret archaeological data-sets both old and new. In the Near East this disparity is compounded by the diversity of dating schemes and interpretative frameworks used by archaeologists studying the region. Faced with these issues, how is it possible to combine such data into a coherent and comprehensive format, adding value to both old and on-going research projects? The Fragile Crescent (AHRC) and Vanishing Landscape (Leverhulme) Projects (Durham University) aim to draw together data derived from archaeological surveys and satellite imagery analysis into a single analytical framework. The projects have developed a methodology for understanding, analysing and presenting disparate chronological, morphological and methodological data across the Ancient Near East. This paper will illustrate how researchers have been able to revitalise old data, adding value through new approaches towards archaeological sites and landscapes via satellite imagery, remote sensing and spatial analyses. We will examine how integrating multiple chronological systems and concepts of ‘uncertainty’ into a single GIS/Database framework can allow for a robust and detailed multi-scalar archaeological landscape analysis. Using case studies from the Fragile Crescent/Vanishing Landscape Projects we will discuss how this methodology has led to new interpretations of urban and non-urban landscapes of the Ancient Near East.

## Old Data Sets, New Interpretations and the Role of Satellite Imagery

Since the pioneering studies of Robert McCormick Adams<sup>1</sup> in Southern Mesopotamia, archaeologists working across the Ancient Near East have developed a large corpus of settlement and landscape data. More recently this has been supplemented by the availability of high resolution satellite imagery and greater access to cartographic information in the form of maps. The primary task of the Vanishing Landscape and Fragile Crescent Projects is to bring together these disparate data sets from across Northern Mesopotamia into a single interpretative framework (Fig. 1). The interpretation of these different sources of information, as well as differences between the methodologies by which the original data were obtained, results in a high degree of complexity. Rather than sweeping this complexity

1 McCormick Adams 1965; McCormick Adams 1981.

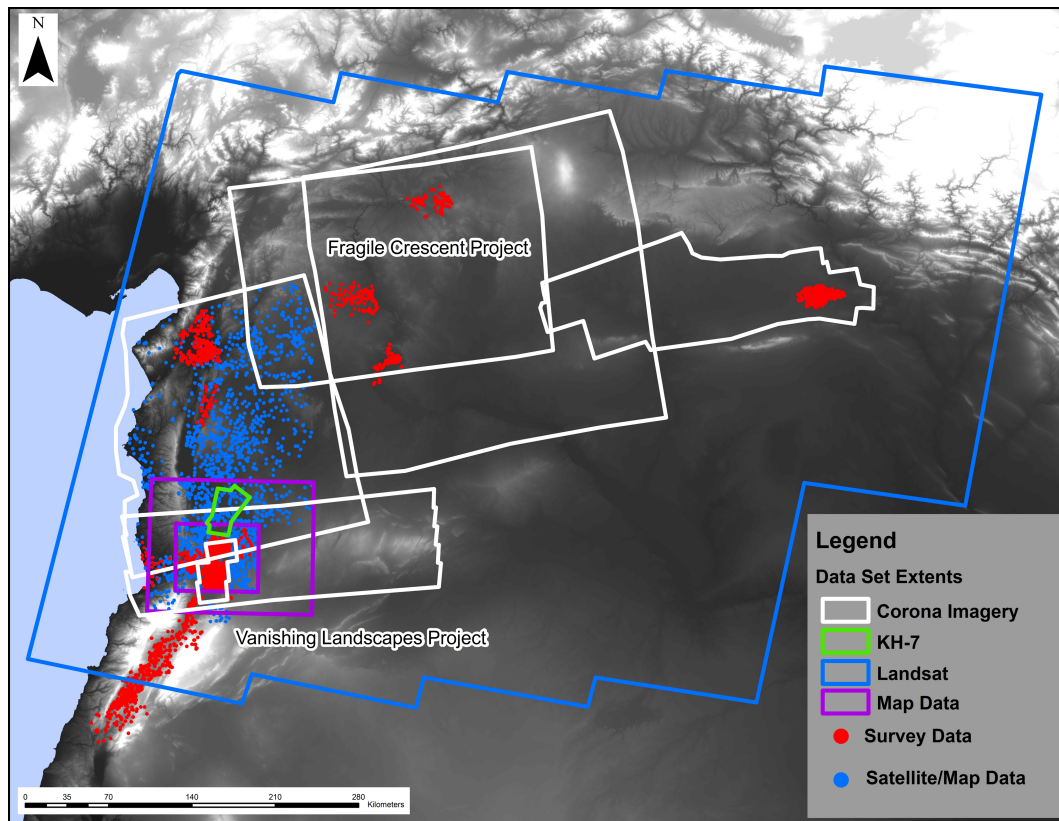


Fig. 1 | Key datasets used in the Fragile Crescent and Vanishing Landscapes Projects. Background: Digital Elevation Model (DEM) derived from Shuttle Radar Topography Mission (SRTM) from February 2000 – Robert Dunford WGS84.

under the carpet, the projects seek to embrace these discrepancies through concepts of certainty and uncertainty. Recording the relationship between data and interpretation allows us to make sense of vast bodies of data at a regional scale.

## Concepts of Certainty and Extrapolation

The collection, interpretation and presentation of field, imagery and cartographic data can be construed through the concept of certainty. When re-interpreting old field data there can be issues in reconstructing the ways in which field collections, survey or excavation was carried out. The extent to which material remains collected and documented at sites are fully representative of the original size or nature of assemblages is not always clear. Sites or landscapes may have been surveyed multiple times and it is important to retain the detail of the original investigations, whilst also allowing for cross-comparisons. Where primary field data does not exist for archaeological sites, data derived from satellite imagery and cartographic sources has been used (Fig. 1). In some cases, combinations of satellite data, place names and map features mean that it is possible to have a fairly high degree of certainty concerning the archaeological significance of a particular geographical location. In other cases, whilst it may be possible to recognise a place name/feature (e.g. “tell”) of archaeological interest on a map, no correlating feature may be distinguishable on satellite imagery, or vice versa. The Vanishing Landscape/Fragile Crescent database allows such variations to be stored and analysed by recording three types of interpretation: Boundary Certainty, Geographical Precision and Archaeological Significance. The first two of these relate to the spatial extent and location of the site or feature in question,

whilst the third relates to the likelihood that the location is of interest to archaeologists. These three categories are designed to encompass all of the issues which are raised by the interpretation of survey data, where site locations and extents may be difficult to assess but archaeological significance is normally known, and imagery/cartographic data, where location is less of an issue but boundary certainty and archaeological significance are more problematic.

By recording information for survey and imagery data in the same area, we can begin to extrapolate from the known to the unknown. For example, survey and imagery analysis in the upland region of the Homs Basalt (Fig. 1) has enabled researchers to identify several distinct settlement morphologies which can be distinguished chronologically from one another based on extrapolation from field surveyed sites. This methodology has also been effective in the lowland areas of the Fragile Crescent Project (Fig. 1) where it has been possible to extrapolate from known surveyed sites and interpret the wider distribution of conical tells. By manipulating different levels of certainty we can begin an analysis of unvisited sites. Maps can be produced, indicating the likelihood of certain morphologies or particular densities of occupation/settlement to be found across the landscape. Moreover, it is possible to identify zones where specific forms of settlement and archaeological activity may be expected, but are absent in the satellite imagery. Such analyses mean we can begin to understand much broader areas than would ever be possible via traditional survey.

## Chronological Modelling of Survey Data

Projects collating data from a variety of sources and projects in the Near East are hampered by significant issues in dating and periodisation; different ceramic and lithic chronologies are used in different ways by different surveys, and even within individual projects some sites, archaeological features or forms of material culture can be more accurately dated than others. Inconsistencies in terminology used across regions may also cause problems. In the Middle Euphrates Zone, for example, each of the four FCP surveys divided the millennia long EBA into Early, Middle and Late phases but none of these phases are of the same length. This can be further contrasted with surveys in the Upper Khabur Valley further east, where surveys generally split the same period into only two phases, an Early and Late EBA. When comparing surveys, we cannot therefore choose a single phase because the actual time periods under discussion would be of different lengths. The solution developed in the FCP, and discussed in this paper, is to use published chronologies to relate each phase to calendar dates in years (Fig. 2). The period between the start and end dates of any given chronological phase is considered the maximum length of time in which a site could be occupied. In the following graphs, attributes of sites are displayed by hundred year blocks. However, different scales can be used for a more nuanced or broader discussion of the trends being examined. Synthetic chronologies<sup>2</sup> provide the basis for this relation, coupled with limited re-evaluation of the ceramics/lithics from the surveys themselves. By transforming the individual phases into a similar metric we can begin to model trends in settlement in a way which allows for direct comparison between surveys. Using this approach we can directly compare settlement at, for example 2300 BC, across the Middle Euphrates region corresponding to the Mid-Late EBA phase in the KHS, and the Late EBA phase in the TS, LCP and SS, with 2200 BC, corresponding to the EBA-transition phase in the KHS and TS and the continuing LEBA in the LCP and SS. This method is only as accurate as the ceramic chronologies involved will allow, but it does permit the analysis of diachronic trends in settlement to be assessed across wide regions.

2 e.g., Lebeau 2000; Cooper 2006; Porter 2007b; Porter 2007a.

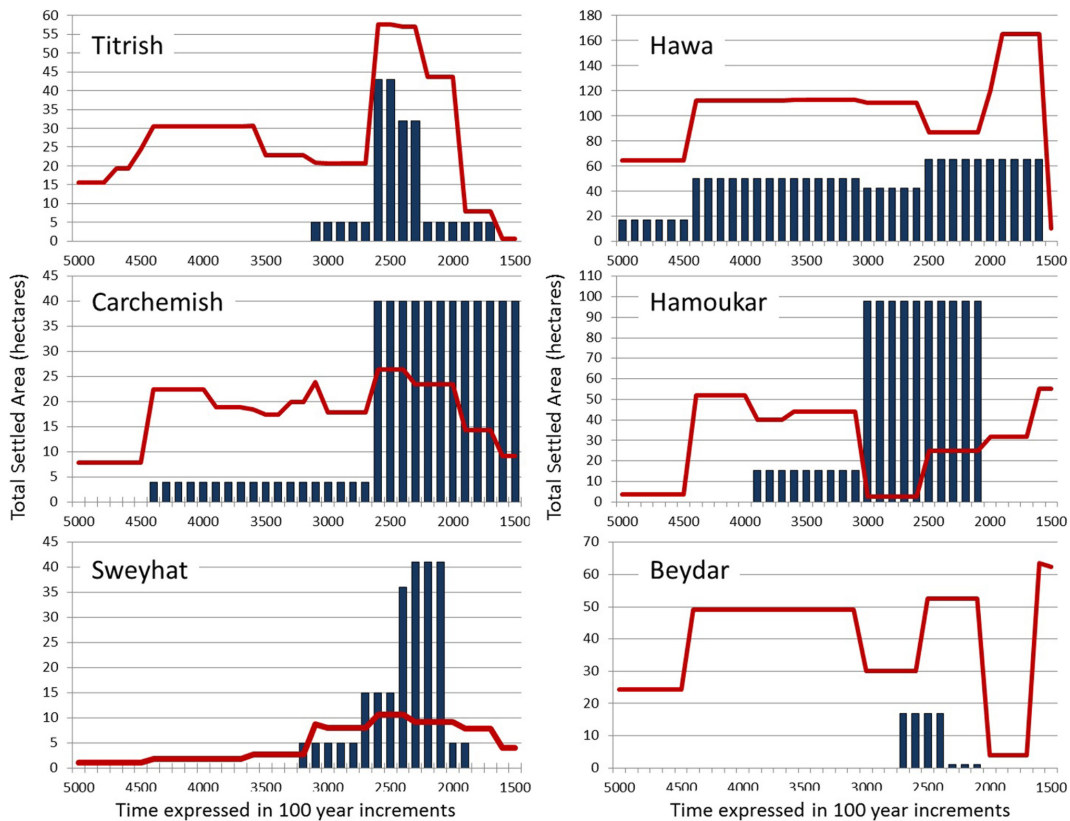


Fig. 2 | Graphs of total settled area for six urban centres in Northern Mesopotamia (blue bars) and total settled area of the surrounding survey area (red lines) for the period between 5000 BC and 1500 BC. Note the data has been constructed by computing the total area for one hundred year time blocks.

## Preliminary Results: Urban Trajectories in the 4th and 3rd Millennia

During the second half of the 3rd millennium BC, Northern Mesopotamia experienced a phase of rapid agglomeration of settlement resulting in the development of a number of large cities, often termed the ‘second urban revolution.’<sup>3</sup> Using the survey data and chronological modelling method proposed above, we can relate the development of several of these urban centres to surrounding settlement. Figure 2 shows the area in hectares of six major urban centres from the river valley of the Middle Euphrates (left side) and the fertile plains of the Upper Khabur Valley (right side), along with the total area of settlement in the immediate surroundings derived from survey, from 5000 BC to 1500 BC. Although factors such as the size and intensity of the survey have a significant effect on these results, we can begin to pick out major trends. Broadly speaking, urbanisation in the Middle Euphrates region was accompanied by a rise in rural settlement, suggesting either an influx of populations from outside the area or possibly the accelerated sedentarisation of previously archaeologically ‘invisible’ mobile pastoralist populations. In contrast, urbanisation in the Khabur Valley coincides with a decline in rural settlement, suggesting populations were drawn into developing urban centres from the surrounding area. A similar contrast can be seen in the decline of urban centres, with settlement in the Middle Euphrates collapsing in the vicinity of Titrish and Sweyhat, as well as in the western part of the Upper Khabur at Tell Beydar. Further east, at Tell

3 Akkermans and Schwartz 2003, 233.

Hawa and Tell Hamoukar, settlement continues and even expands during the Middle Bronze Age. These contrasting urban trajectories require further interpretation, but may be related to the development of new strategies of agro-pastoralism and forms of political economy in the second half of the third millennium, and the subsequent breakdown of this fragile system.<sup>4</sup>

## Conclusions

The combination of technological advances in spatial software, the increasing availability of remote sensing data and the development of a large body of archaeological research provides new and exciting opportunities for archaeologists working in the Middle East. However, the task of bringing such disparate datasets together also presents significant challenges and requires careful consideration. In this paper we have sought to demonstrate how concepts of certainty and precision can help us to retain an understanding of the quality of data which can then be interpreted at a variety of different scales. We have also presented a form of chronological modelling designed to mitigate some of the terminological and temporal differences inherent in large scale archaeological data comparison. It is hoped that such an approach can be of use in similar regional analyses both within the Middle East and further afield.

4 Wilkinson et al. (forthcoming); Philip and Bradbury 2010, 160–162.



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